Marwari college Darbhanga

Subject---physics (Hons)

Class--- B. Sc. Part 2

Paper—04 ; group----B

Topic—BJT common Base Configuration (Basic Electronics)

Lacture series---06

By:- Dr. Sony Kumari,

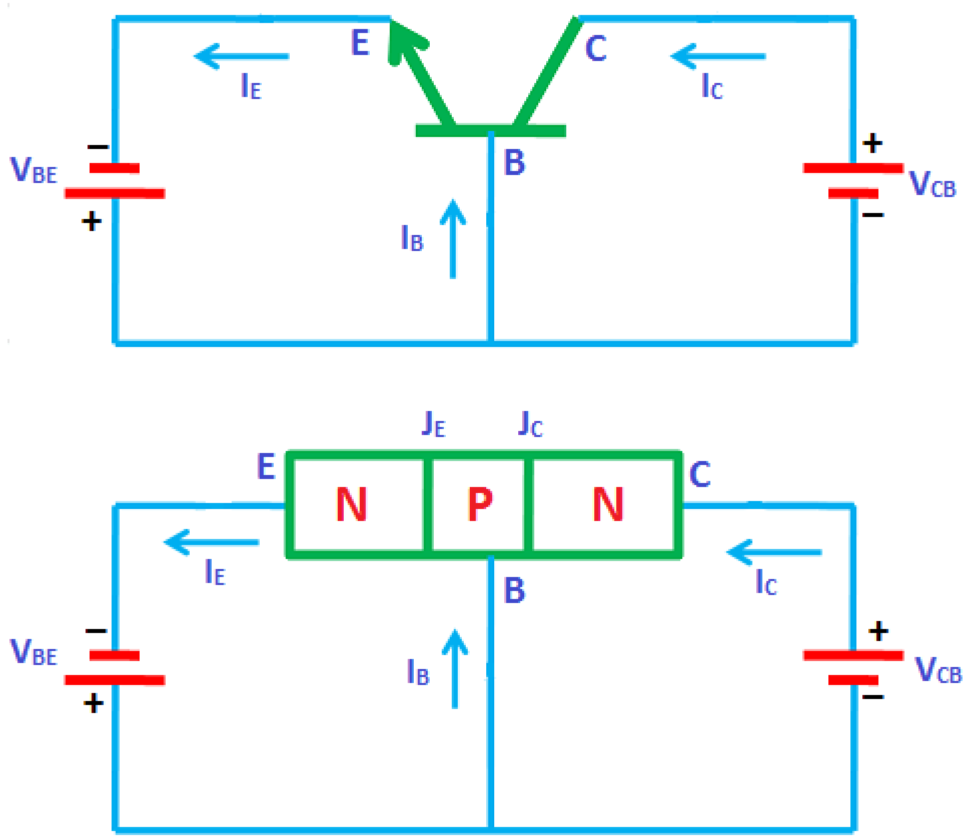
Assistant professor

Marwari college Darbhanga.

Common Base Configuration

In common base configuration, emitter is the input terminal, collector is the output terminal and base terminal is connected as a common terminal for both input and output. That means the emitter terminal and common base terminal are known as input terminals whereas the collector terminal and common base terminal are known as output terminals.

In common base configuration, the base terminal is grounded so the common base configuration is also known as grounded base configuration. Sometimes common base configuration is referred to as common base amplifier, CB amplifier, or CB configuration.



Common base configuration

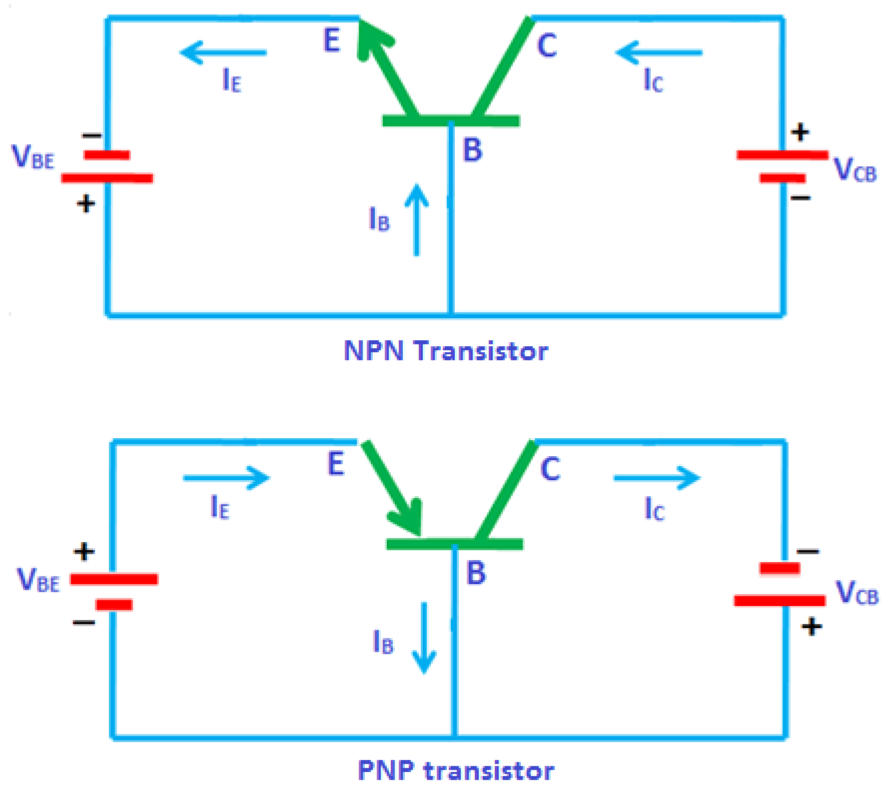
The input signal is applied between the emitter and base terminals while the corresponding output signal is taken across the collector and base terminals. Thus the base terminal of a transistor is common for both input and output terminals and hence it is named as common base configuration.

The supply voltage between base and emitter is denoted by V_{BE} while the supply voltage between collector and base is denoted by V_{CB}.

As mentioned earlier, in every configuration, the base-emitter junction J_E is always forward biased and collector-base junction

J_C is always reverse biased. Therefore, in common base configuration, the base-emitter junction J_E is forward biased and collector-base junction J_C is reverse biased.

The common base configuration for both NPN and PNP transistors is shown in the below figure.



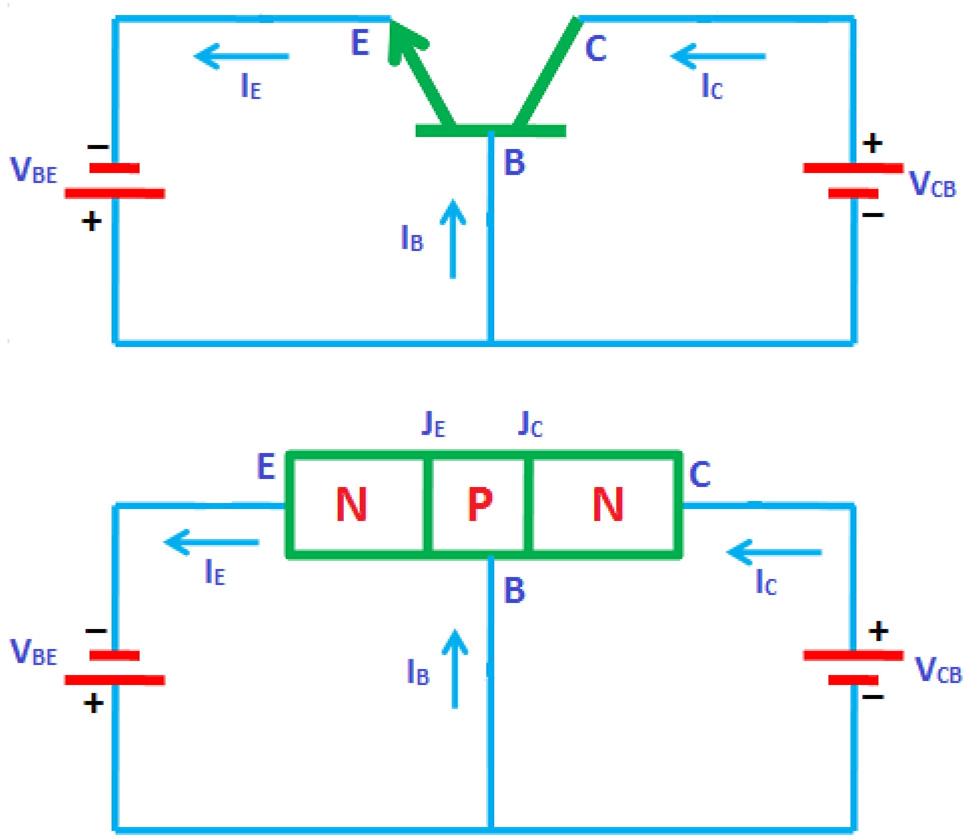
Common base configuration

From the above circuit diagrams of npn and pnp transistors, it can be seen that for both npn and pnp transistors, the input is applied to the emitter and the output is taken from the collector. The common terminal for both the circuits is the base.

Current flow in common base amplifier

For the sake of understanding, let us consider NPN transistor in common base configuration.

The npn transistor is formed when a single p-type semiconductor layer is sandwiched between two n-type semiconductor layers.



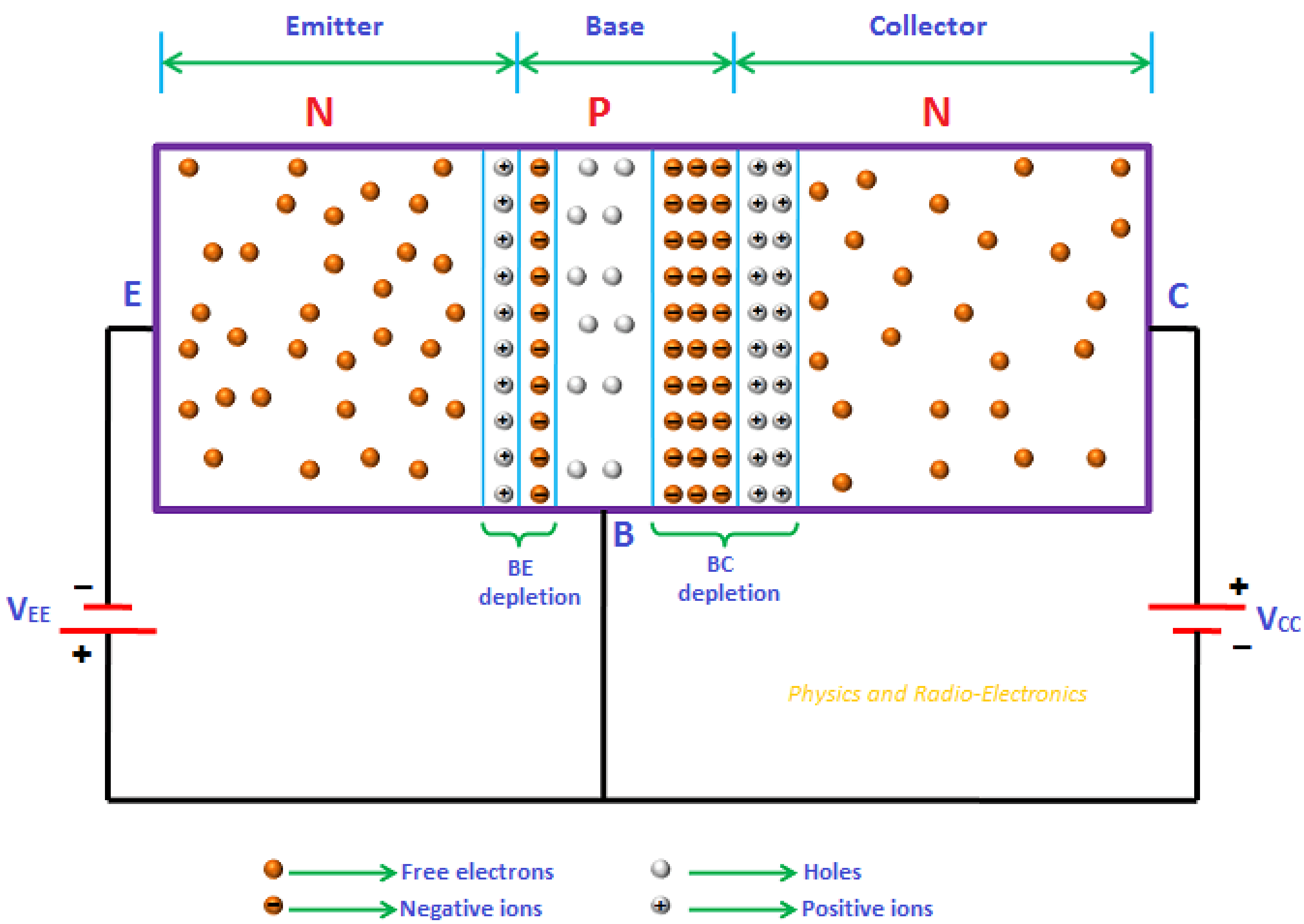
Common base configuration

The base-emitter junction J_E is forward biased by the supply voltage V_{BE} while the collector-base junction J_C is reverse biased by the supply voltage V_{CB}.

Due to the forward bias voltage V_{BE}, the free electrons(majority carriers) in the emitter region experience a repulsive force from the negative terminal of the battery similarly holes (majority carriers) in the base region experience a repulsive force from the positive terminal of the battery.

experience a repulsive force from the positive terminal of the battery.

As a result, free electrons start flowing from emitter to base similarly holes start flowing from base to emitter. Thus free electrons which are flowing from emitter to base and holes which are flowing from base to emitter conducts electric current. The actual current is carried by free electrons which are flowing from emitter to base. However, we follow the direction which is from base to emitter. Thus electric current is produced at the base and emitter region.



The free electrons which are flowing from emitter to base will combine with the holes in the base region similarly the holes which are flowing from base to emitter will combine with the electrons in the emitter region.

From the above figure, it is seen that the width of the base region is very thin. Therefore, only a small percentage of free electrons from emitter region will combine with the holes in the base region and the remaining large number of free electrons cross the base region and enters into the collector region. A large number of free electrons which entered into the collector region will experience an attractive force from the positive terminal of the battery. Therefore, the free electrons in the collector region will flow towards the positive terminal of the battery. Thus, electric current is produced in the collector region.

The electric current produced at the collector region is primarily due to the free electrons from the emitter region similarly the electric current produced at the base region is also primarily due to the free electrons from emitter region. Therefore, the emitter current is greater than the base current and collector current. The emitter current is the sum of base current and collector current.

$$I_E = I_B + I_C$$

We know that emitter current is the input current and collector current is the output current.

The output collector current is less than the input emitter current, so the current gain of this amplifier is actually less than 1. In other words, the common base amplifier attenuates the electric current rather than amplifying it.

The base-emitter junction J_E at input side acts as a forward biased diode. So the common base amplifier has a low input impedance (low opposition to incoming current). On the other hand, the collector-base junction J_C at output side acts somewhat like a reverse biased diode. So the common base amplifier has high output impedance.

Therefore, the common base amplifier provides a low input impedance and high output impedance.

Transistors with low input impedance and high output impedance provide a high voltage gain.

Even though the voltage gain is high, the current gain is very low and the overall power gain of the common base amplifier is low as compared to the other transistor amplifier configurations.

The common base transistor amplifiers are primarily used in the applications where low input impedance is required.

The common base amplifier is mainly used as a voltage amplifier or current buffer.

This type of transistor arrangement is not very common and is not as widely used as the other two transistor configurations.

The working principle of pnp transistor with CB configuration is same as the npn transistor with CB configuration. The only difference is in npn transistor free electrons conduct most of the current whereas in pnp transistor the holes conduct most of the current.

To fully describe the behavior of a transistor with CB configuration, we need two set of characteristics: they are

1. Input characteristics
2. Output characteristics.

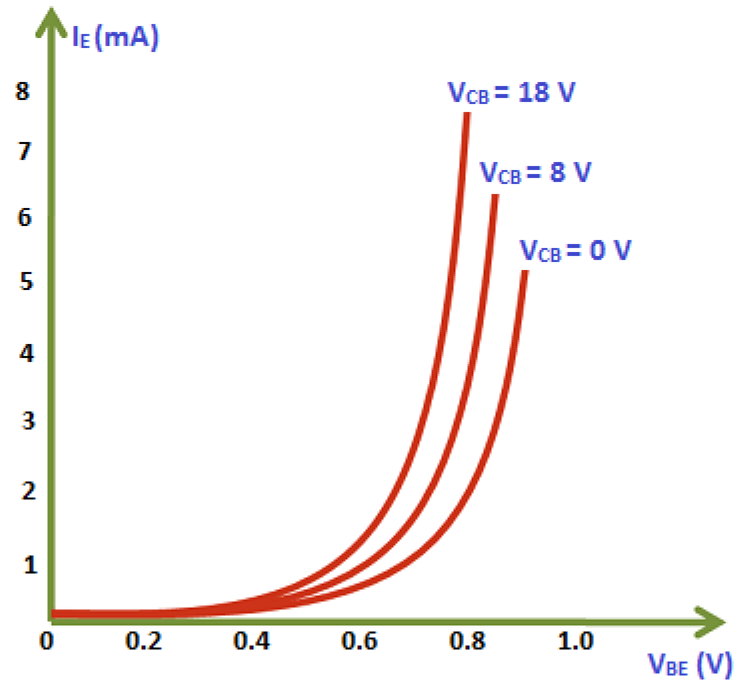
Input characteristics

The input characteristics describe the relationship between input current (I_E) and the input voltage (V_{BE}).

First, draw a vertical line and horizontal line. The vertical line represents y-axis and horizontal line represents x-axis. The input current or emitter current (I_E) is taken along the y-axis (vertical line) and the input voltage (V_{BE})is taken along the x-axis (horizontal line).

To determine the input characteristics, the output voltage V_{CB} (collector-base voltage) is kept constant at zero volts and the input voltage V_{BE} is increased from zero volts to different voltage levels. For each voltage level of the input voltage (V_{BE}), the input current (I_E) is recorded on a paper or in any other form.

A curve is then drawn between input current I_E and input voltage V_{BE} at constant output voltage V_{CB} (0 volts).



I/p characteristics CB configuration

Next, the output voltage (V_{CB}) is increased from zero volts to a certain voltage level (8 volts) and kept constant at 8 volts. While increasing the output voltage (V_{CB}), the input voltage (V_{BE}) is kept constant at zero volts. After we kept the output voltage (V_{CB}) constant at 8 volts, the input voltage V_{BE} is increased from zero volts to different voltage levels. For each voltage level of the input voltage (V_{BE}), the input current (I_E) is recorded on a paper or in any other form.

A curve is then drawn between input current I_E and input voltage V_{BE} at constant output voltage V_{CB} (8 volts).

This is repeated for higher fixed values of the output voltage (V_{CB}).

When output voltage (V_{CB}) is at zero volts and emitter-base junction J_E is forward biased by the input voltage (V_{BE}), the emitter-base junction acts like a normal p-n junction diode. So the input characteristics are same as the forward characteristics of a normal pn junction diode.

The cut in voltage of a silicon transistor is 0.7 volts and germanium transistor is 0.3 volts. In our case, it is a silicon transistor. So from the above graph, we can see that after 0.7 volts, a small increase in input voltage (V_{BE}) will rapidly increase the input current (I_E).

When the output voltage (V_{CB}) is increased from zero volts to a certain voltage level (8 volts), the emitter current flow will be increased which in turn reduces the depletion region width at emitter-base junction. As a result, the cut in voltage will be reduced. Therefore, the curves shifted towards the left side for higher values of output voltage V_{CB}.